

From King's Dutch Academy of Sciences The Dutch Research Agenda

“Information technology (IT) now permeates all aspects of public, commercial, social, and personal life. bank cards, satnav, and weather radar... IT has become completely indispensable.”

“But to **guarantee** the **reliability** and **quality** of constantly **bigger** and more **complicated** IT, we will need to find answers to some **fundamental questions!**”

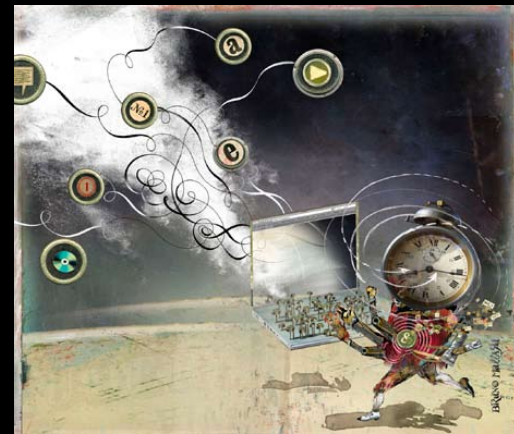


Reduction of Complexity by Integration

By combining services such as telephony, television, data, and computing capacity within a single network, we can cut down on complexity, energy consumption and maintenance.

- How can we describe and analyze complex information systems effectively?
- How can we specify and measure the quality and reliability of a system?
- How can we combine various different systems?
- How can we design systems in which separate processors can co-operate efficiently via mutual network connections within a much larger whole?
- Can we design information systems that can diagnose their own malfunctions and perhaps even repair them?
- How can we specify, predict, and measure system performance as effectively as possible?

SNE addresses a.o. the highlighted questions!



Mission

Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

- *Capacity*
- *Capability*
- *Security*
- *Sustainability*
- *Resilience*

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- *Capability*
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- *Security*
 - *Anonymity, integrity of data in distributed data processing*
- *Sustainability*
 - *Greening infrastructure, awareness*
- *Resilience*
 - *Systems under attack, failures, disasters*



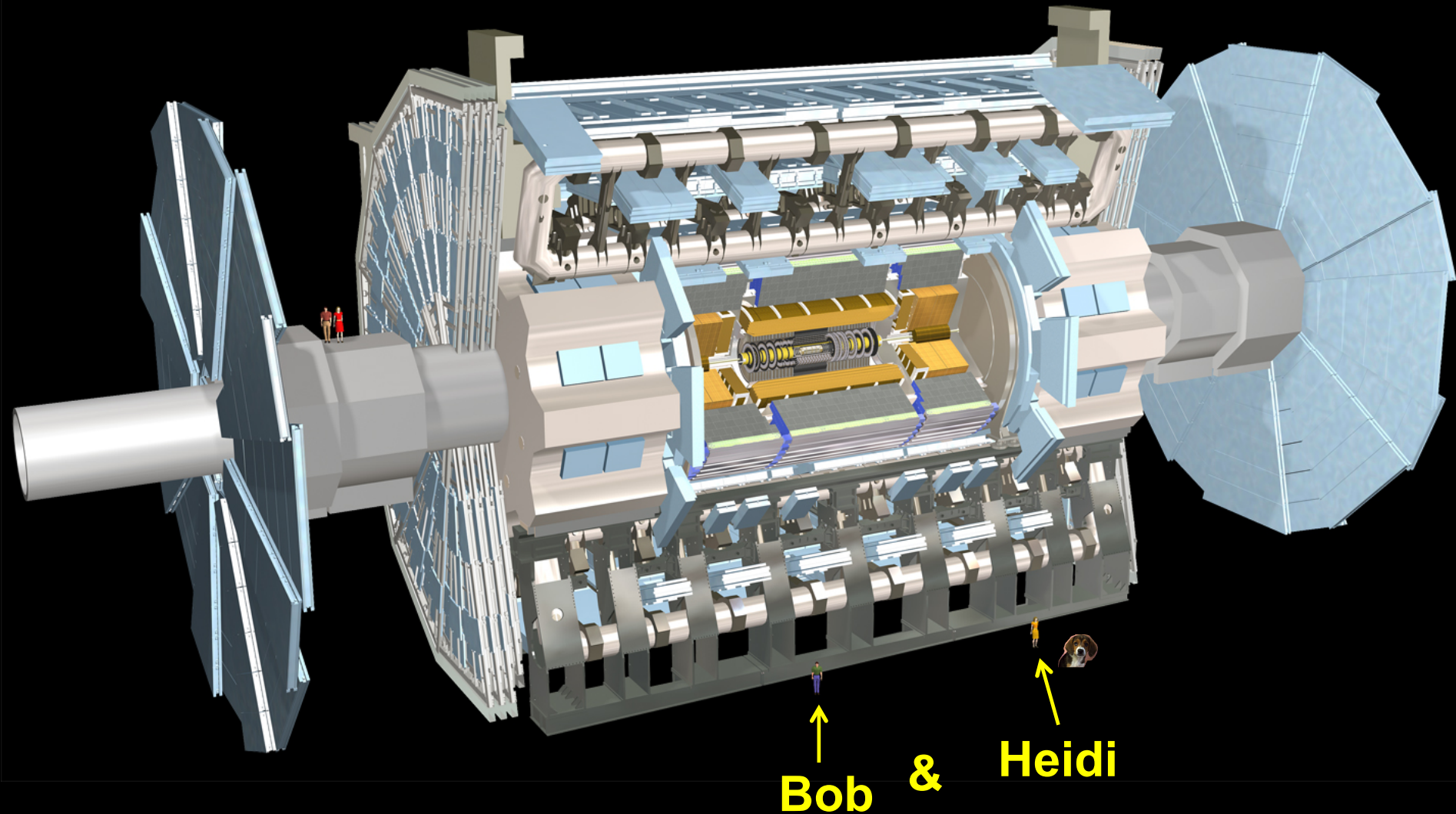
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ATLAS detector @ CERN Geneve

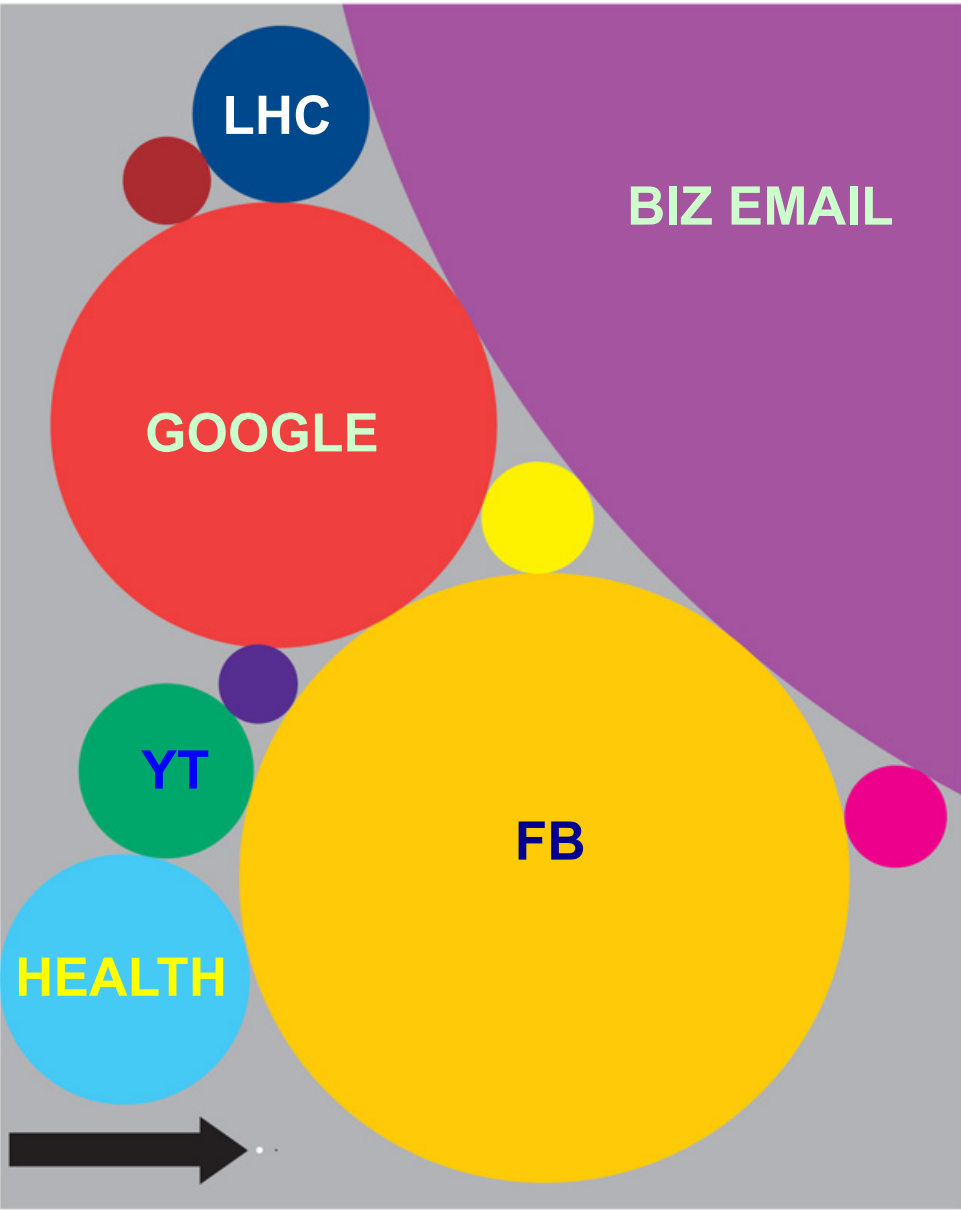


What Happens in an Internet Minute?



And Future Growth is Staggering





There
is
always
a
bigger
fish

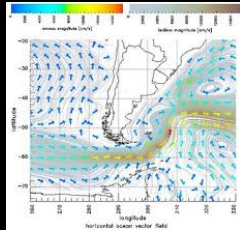
Size of data sets in terabytes

Business email sent per year	2,986,100	National Climactic Data Center database	6,144
Content uploaded to Facebook each year	182,500	Library of Congress' digital collection	5,120
Google's search index	97,656	US Census Bureau data	3,789
Kaiser Permanente's digital health records	30,720	Nasdaq stock market database	3,072
Large Hadron Collider's annual data output	15,360	Tweets sent in 2012	19
Videos uploaded to YouTube per year	15,000	Contents of every print issue of WIRED	1.26

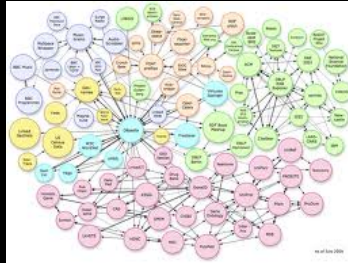
... more data!

Internet developments

Google



DATA



... more realtime!



twitter



myspace
a place for freedom



LinkedIn



SchoolBANK

Hyves

flickr
from YAHOO!



... more users!



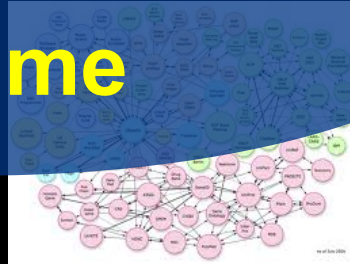
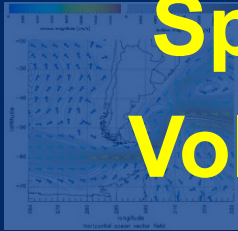
... more data!

Internet developments

Google

Speed
Volume

DATA



Deterministic

Real-time



twitter



Scalable

Secure

LinkedIn



myspace
SchoolBANK

Hyves

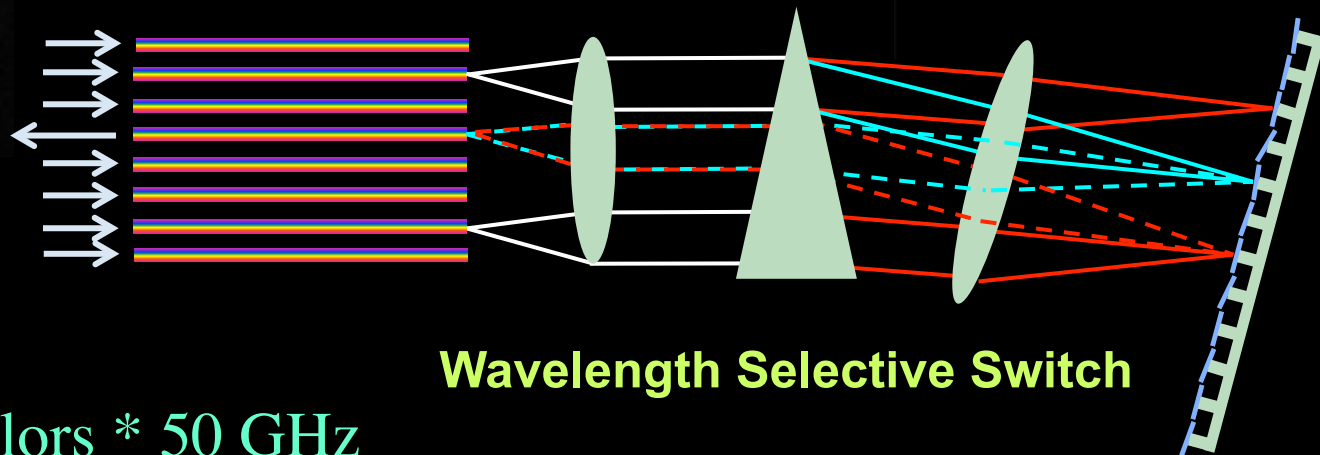
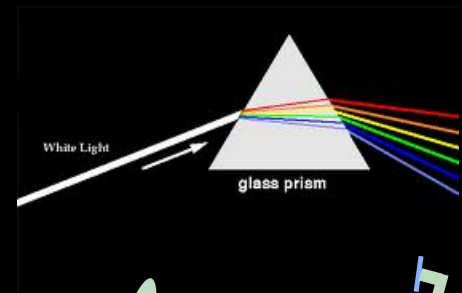
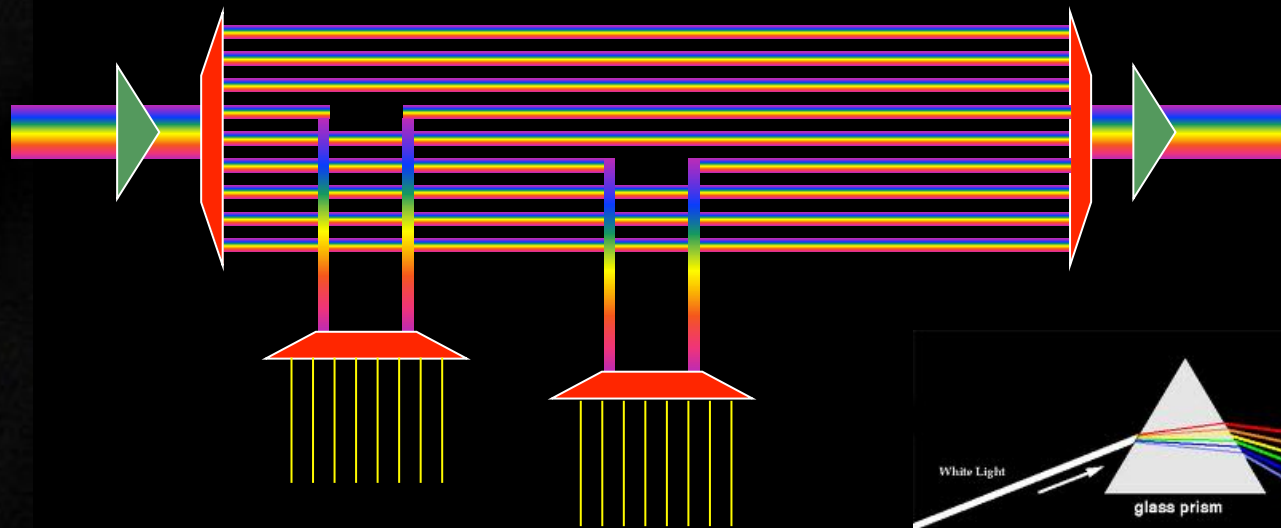
flickr
from YAHOO!



... more users!



Multiple colors / Fiber



Wavelength Selective Switch

Per fiber: $\sim 80-100$ colors * 50 GHz

Per color: 10 – 40 – 100 Gbit/s

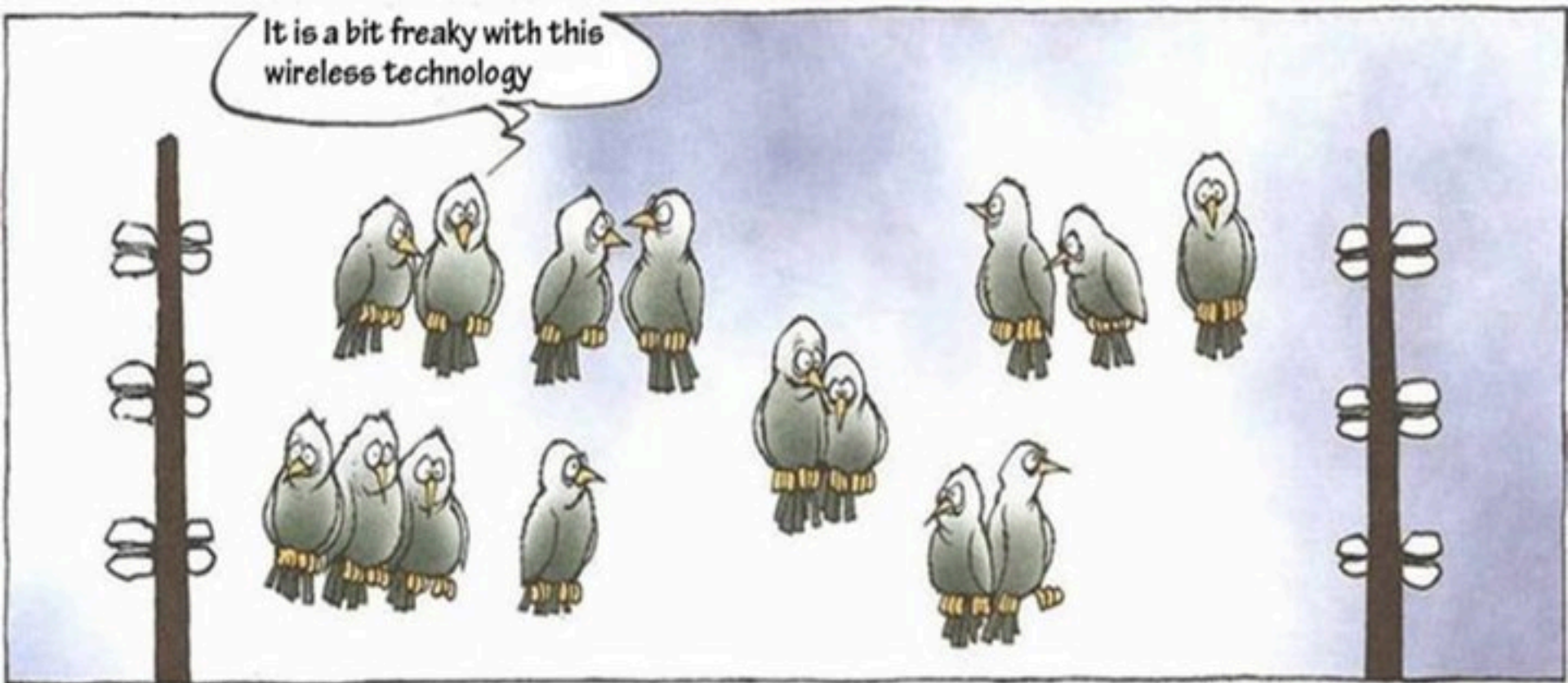
BW * Distance $\sim 2 * 10^{17}$ bm/s

New: Hollow Fiber!

→ less RTT!



Wireless Networks

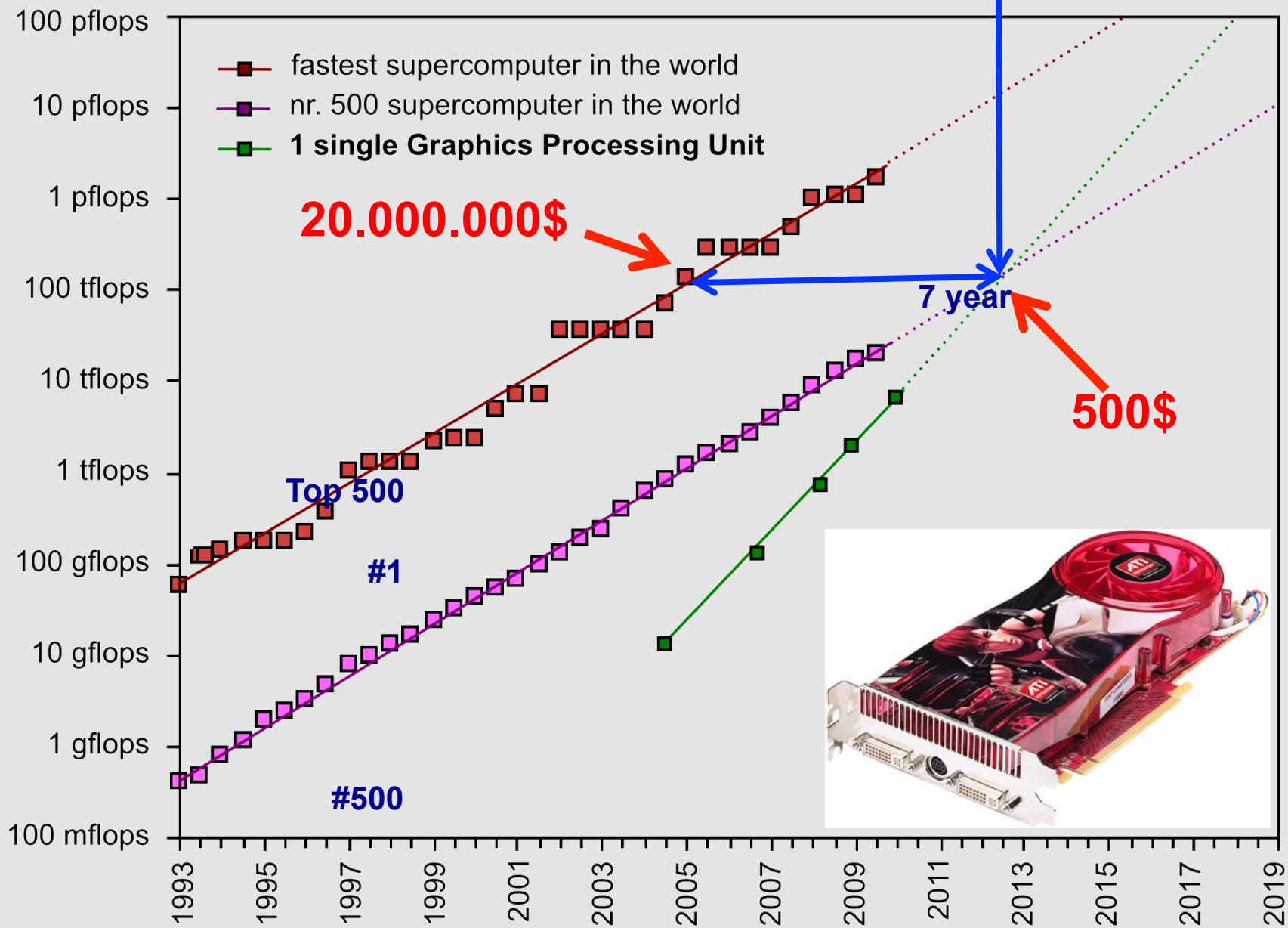


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protocol LAN due to the easy comparison and convenience in the **digital home**. While consumer PC products has just started to migrate to a much higher bandwidth of 802.11n wireless LAN now working on next-generation standard definition is already in progress.



GPU cards are disruptive!

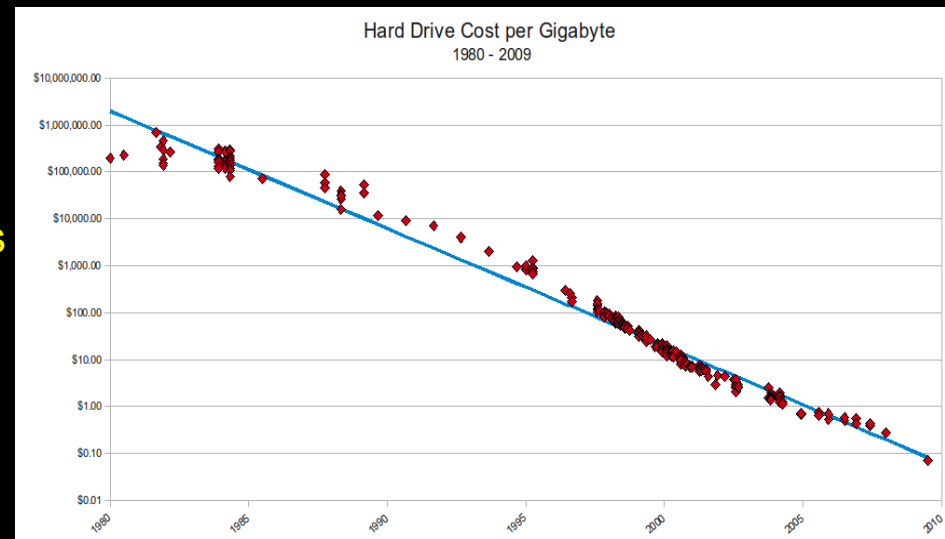


Reliable and Safe!

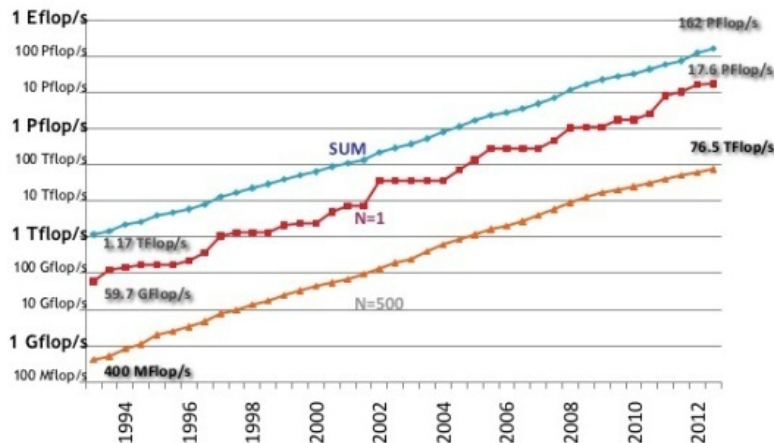
This omnipresence of IT makes us not only strong but also vulnerable.

- A virus, a hacker, or a system failure can instantly send digital shockwaves around the world.

The hardware and software that allow all our systems to operate is becoming bigger and more complex all the time, and the capacity of networks and data storage is increasing by leaps and bounds.



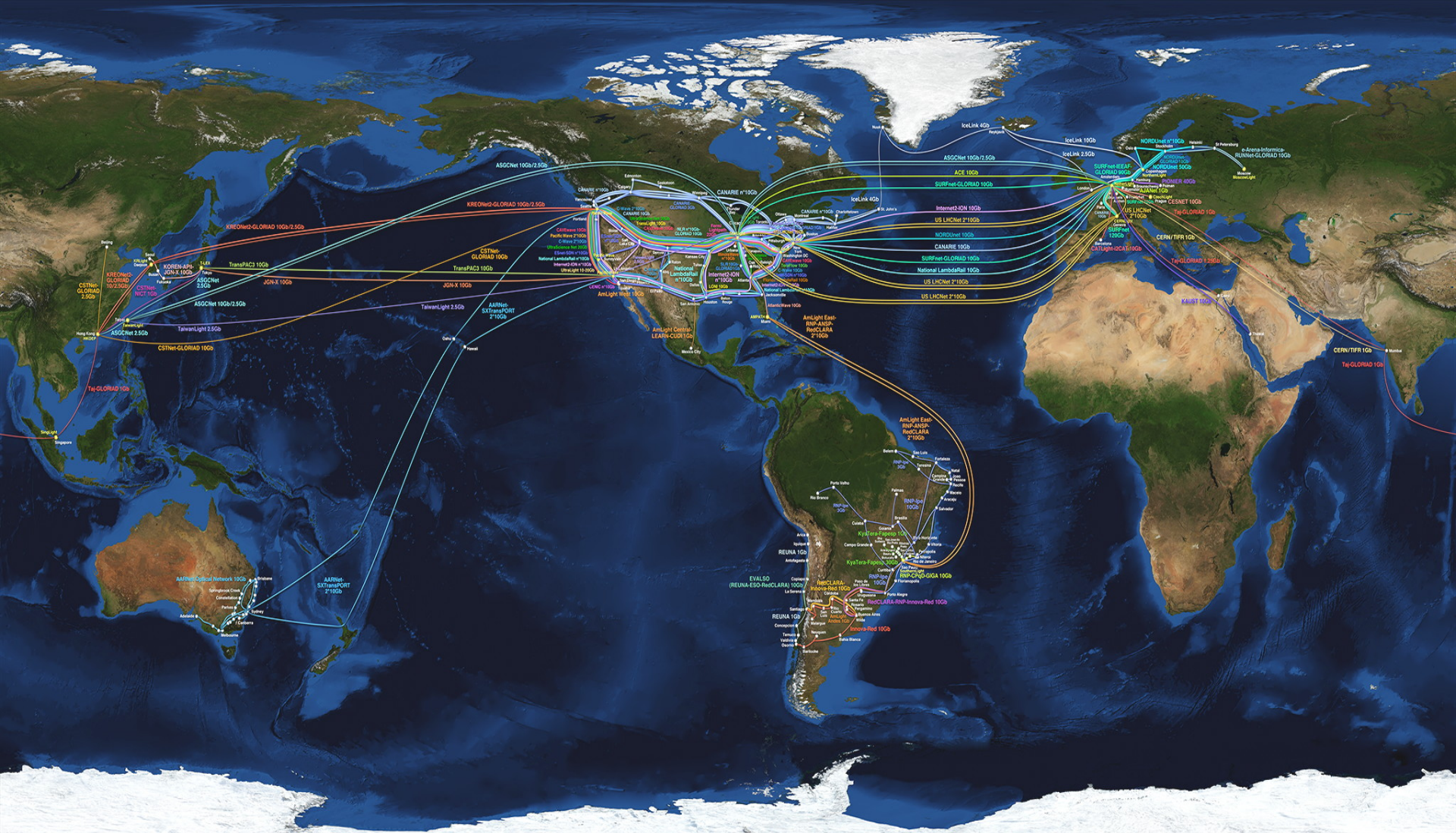
Performance Development



We will soon reach the limits of what is currently feasible and controllable.

The GLIF – LightPaths around the World

F Dijkstra, J van der Ham, P Grosso, C de Laat, “A path finding implementation for multi-layer networks”, Future Generation Computer Systems 25 (2), 142-146.



ExoGeni @ OpenLab - UvA

Installed and up June 3th 2013



Connected via the new 100 Gb/s transatlantic To US-GENI

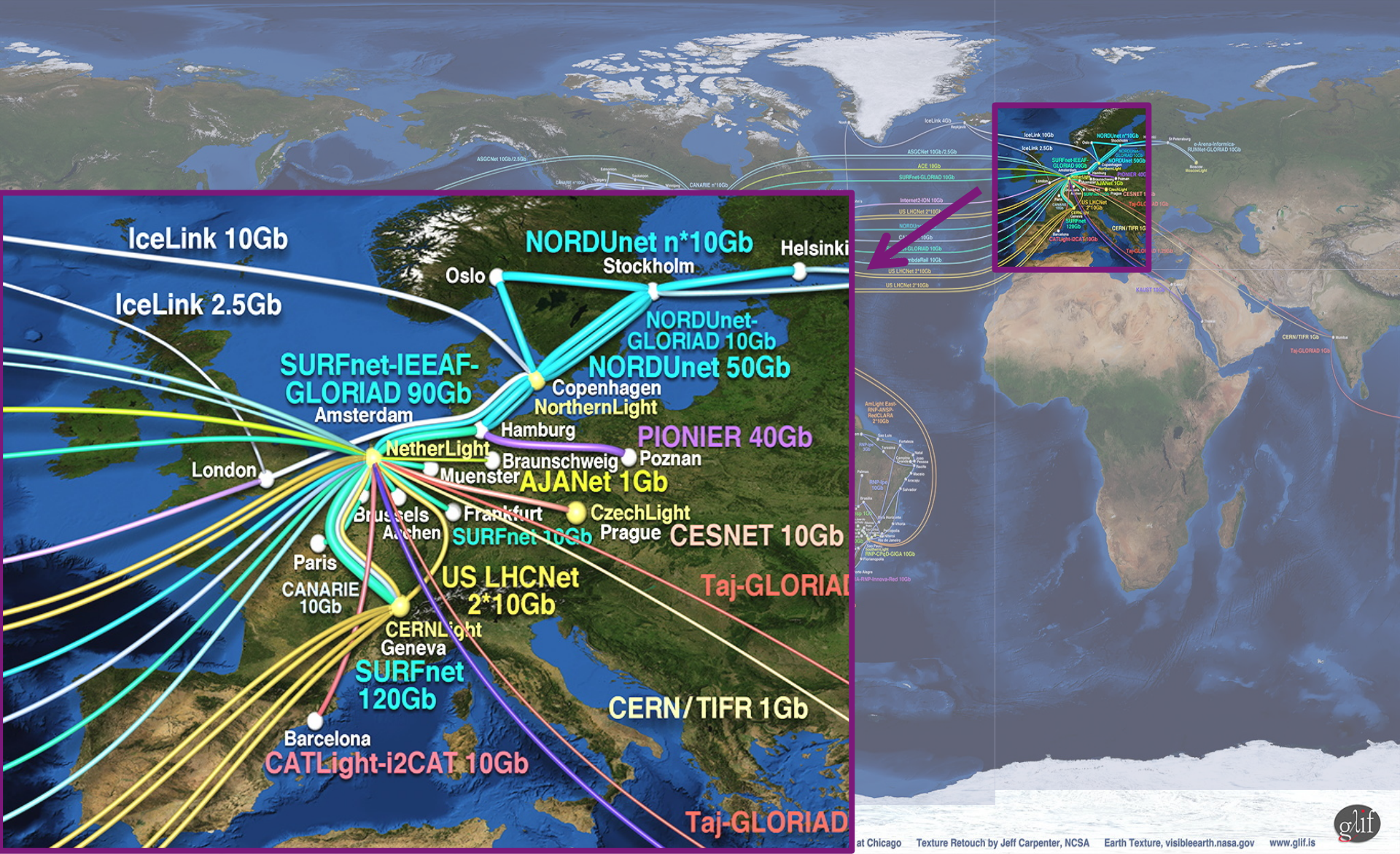
TNC2013 DEMOS JUNE, 2013

DEMO	TITLE	OWNER	AFFILIATION	E-MAIL	A-SIDE	Z-SIDE	PORTS(S) MAN LAN	PORTS(S) TNC2013	DETAILS
1	Big data transfers with multipathing, OpenFlow and MPTCP	Ronald van der Pol	SURFnet	ronald.vanderpol@surfnet.nl	TNC/MECC, Maastricht NL	Chicago, IL	Existing 100G link between internet2 and ESnet	2x40GE (Juniper)-2x10GE (OME6500)	In this demonstration we show how multipathing, OpenFlow and Multipath TCP (MPTCP) can help in large file transfers between data centres (Maastricht and Chicago). An OpenFlow application provisions multiple paths between the servers and MPTCP will be used on the servers to simultaneously send traffic across all these paths. This demo uses 2x40GE on the transatlantic 100G link. ESnet provides 2x40G between MAN LAN and StarLight, ACE and USLHCnet provide additional 10GEs.
2	Visualize 100G traffic	Inder Monga	ESnet	imonga@es.net					Using an SNMP feed from the Juniper switch at TNC2013 and/or Brocade AL25 node in MANLAN, this demo would visualize the total traffic on the link, of all demos aggregated. The network diagram will show the transatlantic topology and some of the demo topologies.
3	How many modern servers can fill a 100Gbps Transatlantic Circuit?	Inder Monga	ESnet	imonga@es.net	Chicago, Ill	TNC showfloor	1x 100GE	8x 10GE	In this demonstration, we show that with the proper tuning and test, only 2 hosts on each continent can generate almost 80Gbps of traffic. Each server has 4 10G NICs connected to a 40G virtual circuit, and has iperf3 running to generate traffic. ESnet's new 'iperf3' throughput measurement tool, still in beta, combines the best features from other tools such as iperf, netperf, and netperf. See: https://my.surfnet.nl/demos/tnc2013/
4	First European ExoGeni at Work	Jeroen van der Ham	UvA	vdham@uva.nl	RENCI, NC	UvA, Amsterdam, NL	1x 10GE	1x 10GE	The ExoGENI racks at RENC1 and UvA will be interconnected over a 100 pipe and be on continuously, showing GENI connectivity between Amsterdam and the rest of the GENI nodes in the USA.
5	Up and down North Atlantic @ 100G	Michael Enrico	DANTE	michael.enrico@dante.net	TNC showfloor	TNC showfloor	1x 100GE	1x 100GE	The DANTE 100GE test set will be placed at the TNC2013 showfloor and connected to the Juniper at 100G. When this demo is running a loop @ MAN LAN's Brocade switch will ensure that the traffic sent to MAN LAN returns to the showfloor. On display is the throughput and RTT (to show the traffic travelled the Atlantic twice)



Amsterdam is a major hub in The GLIF

F Dijkstra, J van der Ham, P Grosso, C de Laat, "A path finding implementation for multi-layer networks", Future Generation Computer Systems 25 (2), 142-146.



Alien light From idea to realisation!

40Gb/s alien wavelength transmission via a multi-vendor 10Gb/s DWDM infrastructure



Alien wavelength advantages

- Direct connection of customer equipment^[1] → cost savings
- Avoid OEO regeneration → power savings
- Faster time to service^[2] → time savings
- Support of different modulation formats^[3] → extend network lifetime

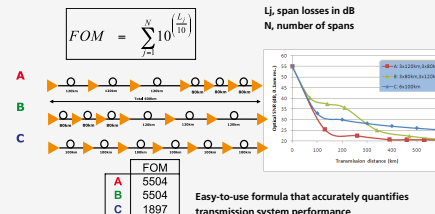
Alien wavelength challenges

- Complex end-to-end optical path engineering in terms of linear (i.e. OSNR, dispersion) and non-linear (FWM, SPM, XPM, Raman) transmission effects for different modulation formats.
- Complex interoperability testing.
- End-to-end monitoring, fault isolation and resolution.
- End-to-end service activation.

In this demonstration we will investigate the performance of a 40Gb/s PM-QPSK alien wavelength installed on a 10Gb/s DWDM infrastructure.

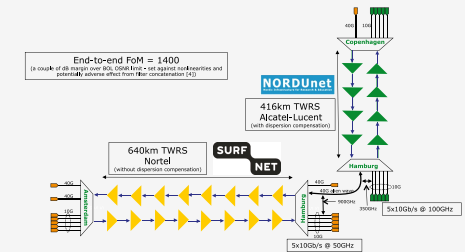
New method to present fiber link quality, FoM (Figure of Merit)

In order to quantify optical link grade, we propose a new method of representing system quality: the FOM (Figure of Merit) for concatenated fiber spans.

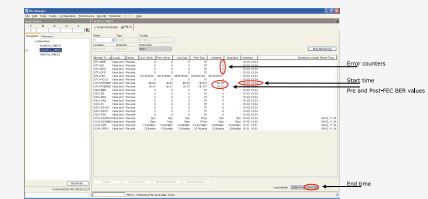


Transmission system setup

JOINT SURFnet/NORDUnet 40Gb/s PM-QPSK alien wavelength DEMONSTRATION.



Test results



Error-free transmission for 23 hours, 17 minutes → BER < 3,0 10⁻¹⁶

Conclusions

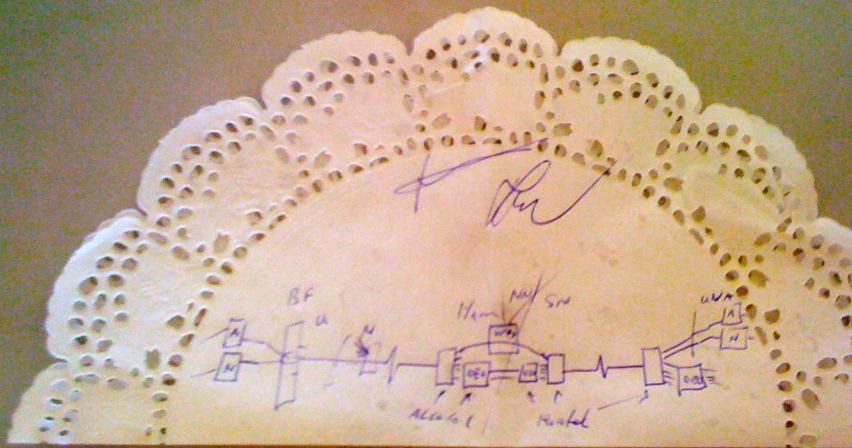
- We have investigated experimentally the all-optical transmission of a 40Gb/s PM-QPSK alien wavelength via a concatenated native and third party DWDM system that both were carrying live 10Gb/s wavelengths.
- The end-to-end transmission system consisted of 1056 km of TWRS (TrueWave Reduced Slope) transmission fiber.
- We demonstrated error-free transmission (i.e. BER below 10⁻¹⁵) during a 23 hour period.
- More detailed system performance analysis will be presented in an upcoming paper.



REFERENCES
ACKNOWLEDGEMENTS

[1] "OPERATIONAL SOLUTIONS FOR AN OPEN DWDM LAYER", O. GERSTEL ET AL. OFC2009 | [2] "AT&T OPTICAL TRANSPORT SERVICES", BARBARA E. SMITH, OFC'09
[3] "OPEX SAVINGS OF ALL-OPTICAL CORE NETWORKS", ANDREW LORD AND CARL ENGINEER, ECCO2009 | [4] NORTEL/SURFNET INTERNAL COMMUNICATION
WE ARE GRATEFUL TO NORDUNET FOR PROVIDING US WITH BANDWIDTH ON THEIR DWDM LINK FOR THIS EXPERIMENT AND ALSO FOR THEIR SUPPORT AND ASSISTANCE DURING THE EXPERIMENTS. WE ALSO ACKNOWLEDGE TELINDUS AND NORTEL FOR THEIR INTEGRATION WORK AND SIMULATION SUPPORT

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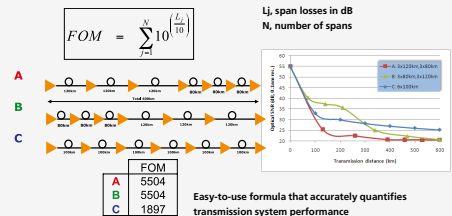
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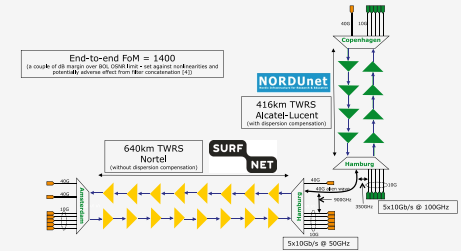
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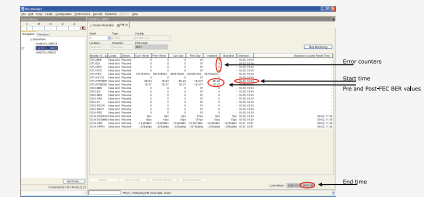


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INDL

An effort started in 2010 (in parallel with our involvement in the FP7 projects Geysers and NOVI).

The goal was to capture the concept of virtualization in computing infrastructures and to describe the storage and computing capabilities of the resources.

A key feature is the decoupling of virtualization, connectivity and functionalities.

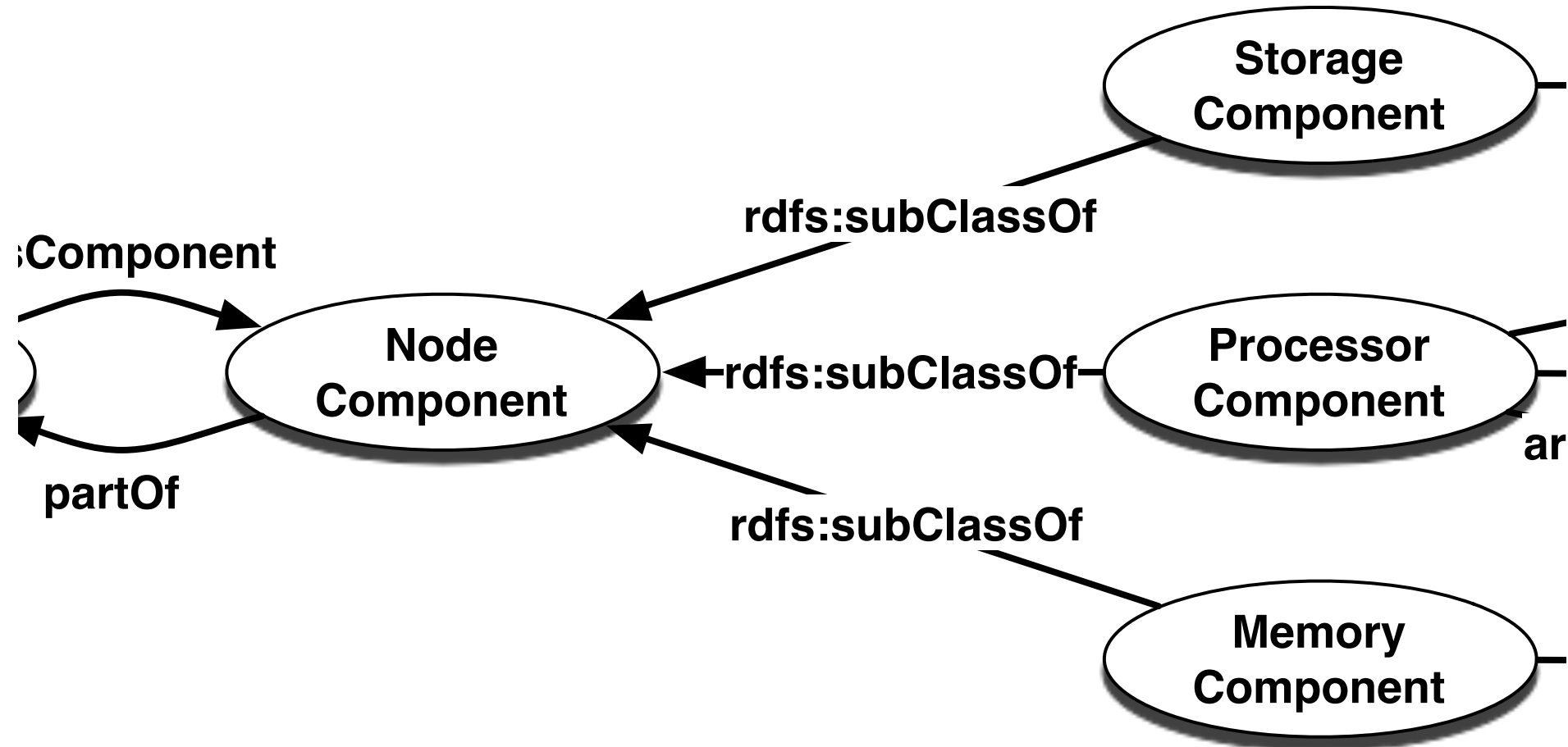
It is built upon the NML ontology.

It uses the **nml:node** concept as basic entity to describe resources in computing infrastructures.

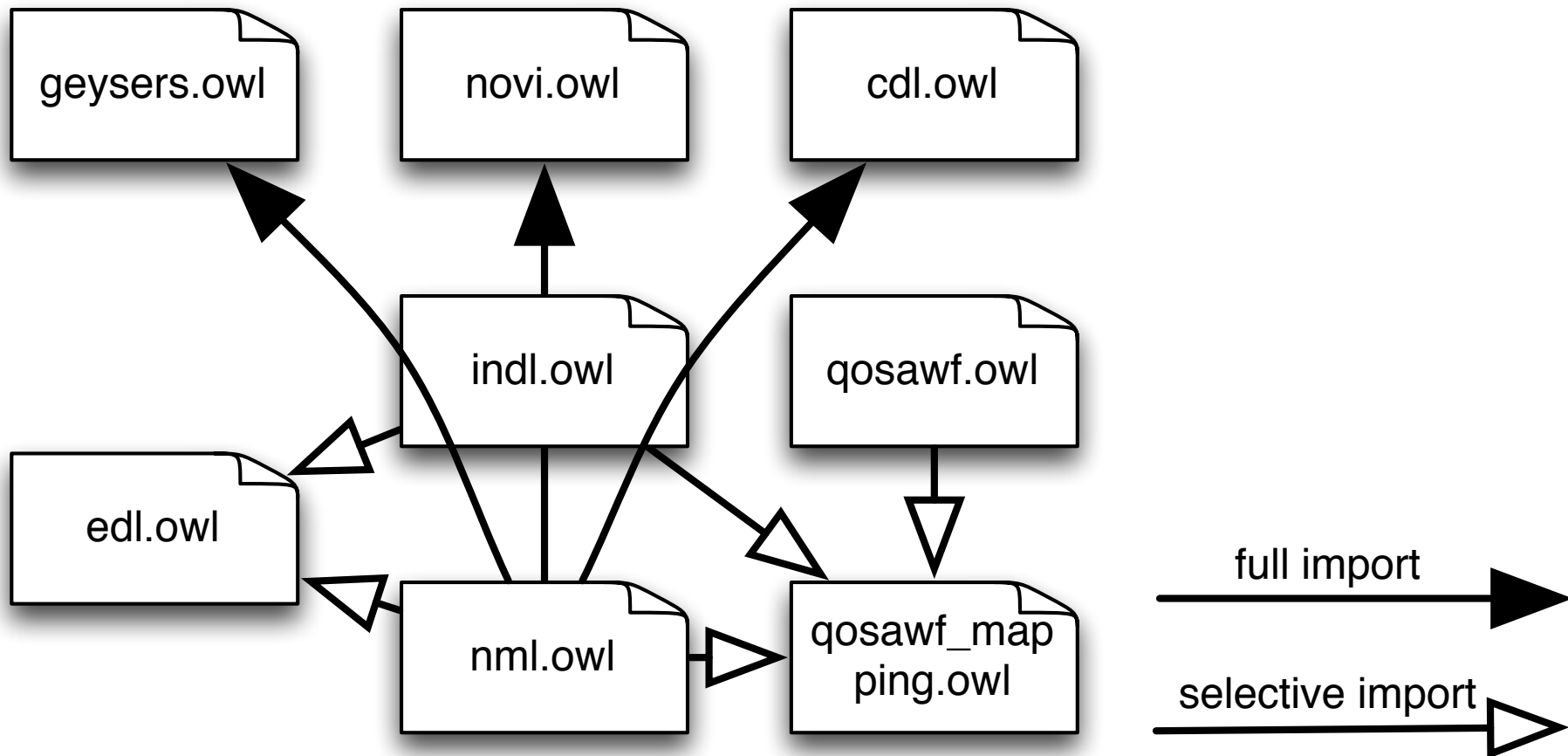
It can be used as:

- a stand-alone model (i.e. without any network descriptions),
- in combination with NML by importing the NML ontology into the INDL definition.

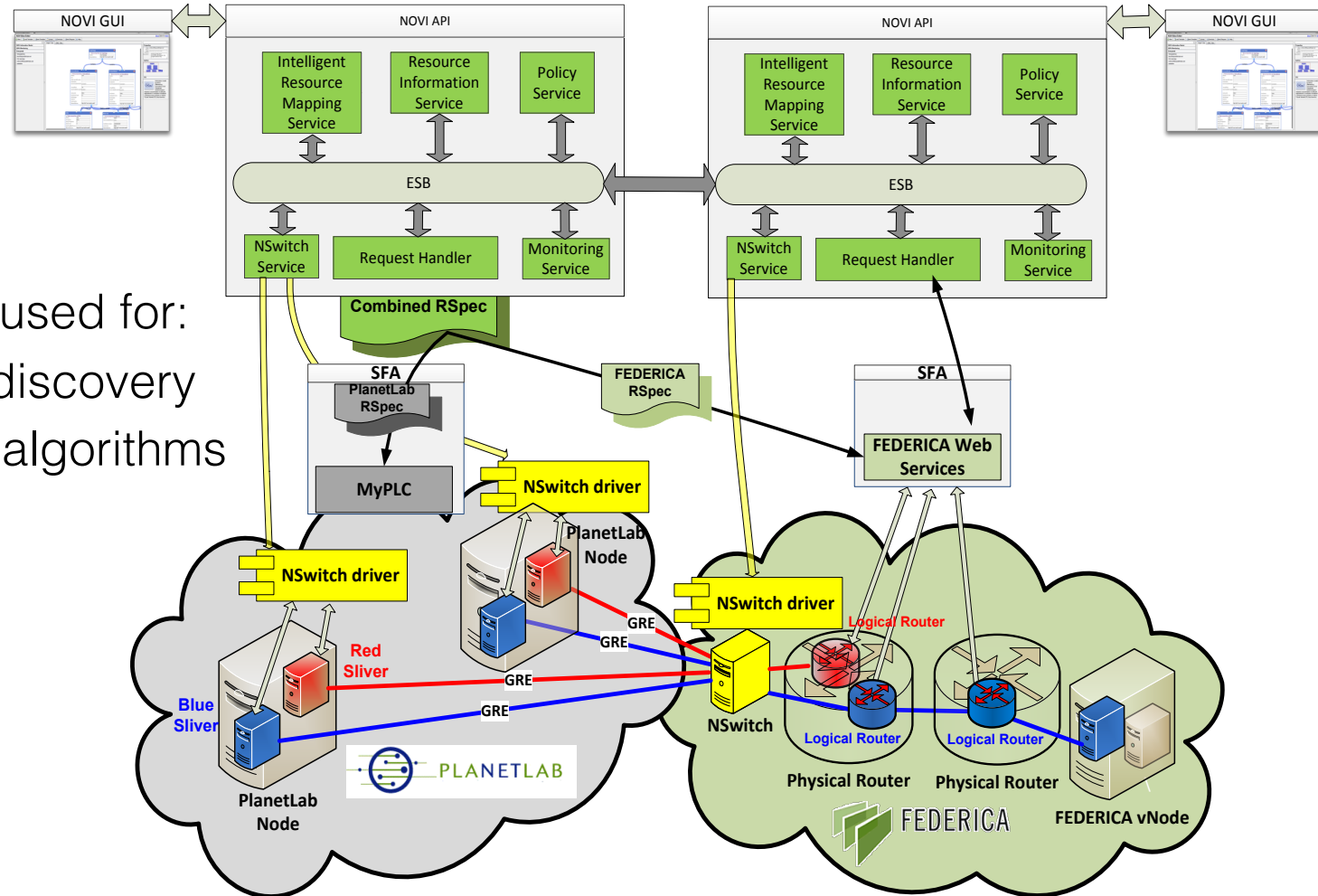
Node components



Our connecting models



NOVI Federation

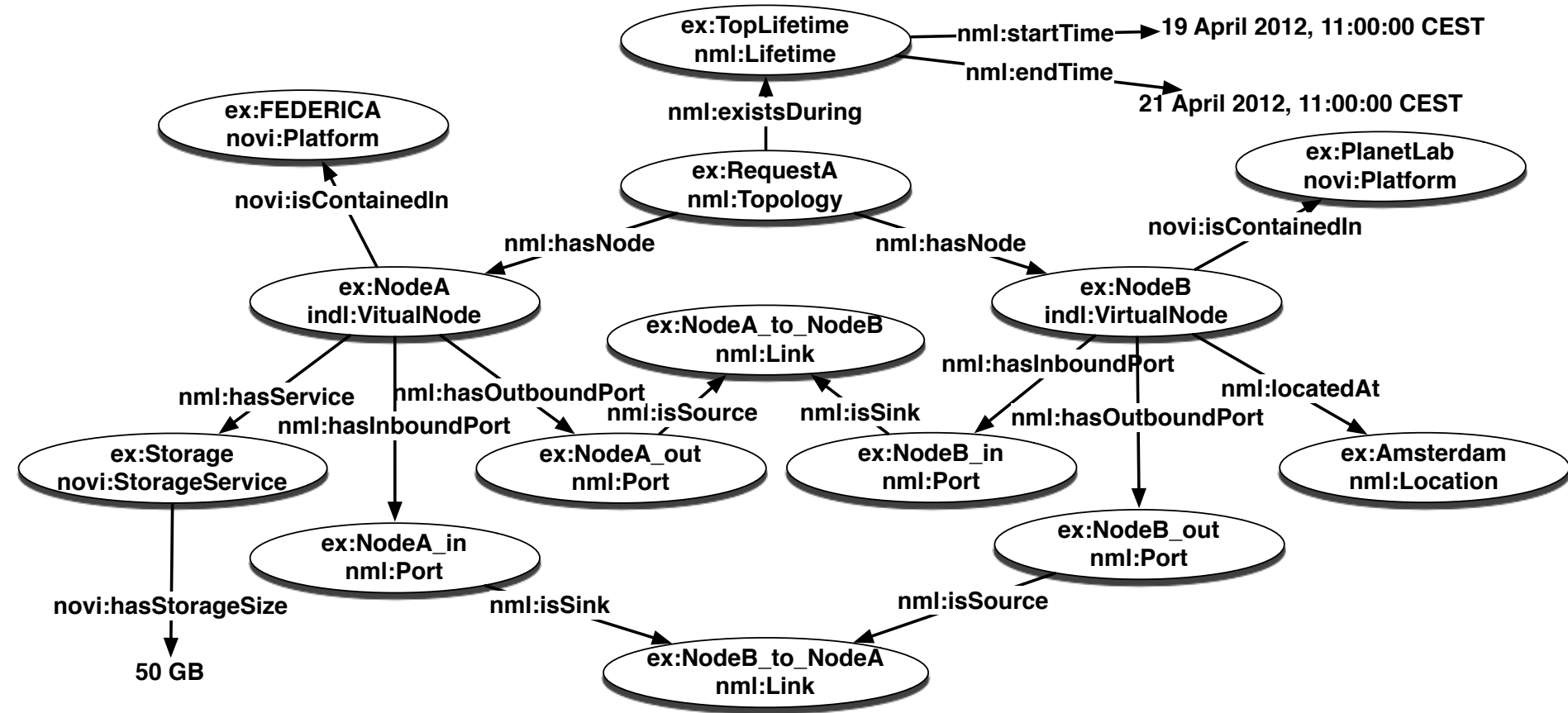


Our model is used for:

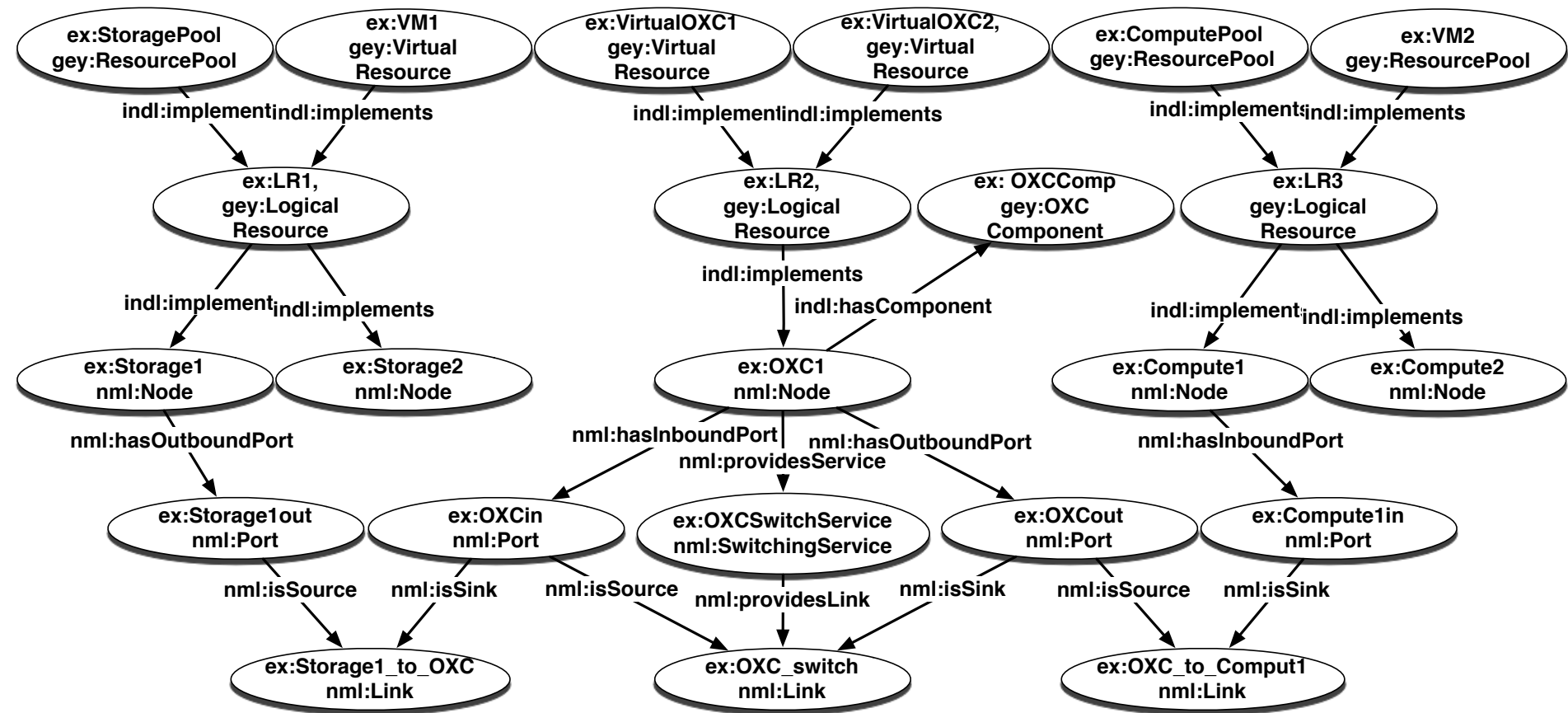
- Resource discovery
- Embedding algorithms

INDL use in NOVI

- Two nodes in the NOVI federation:

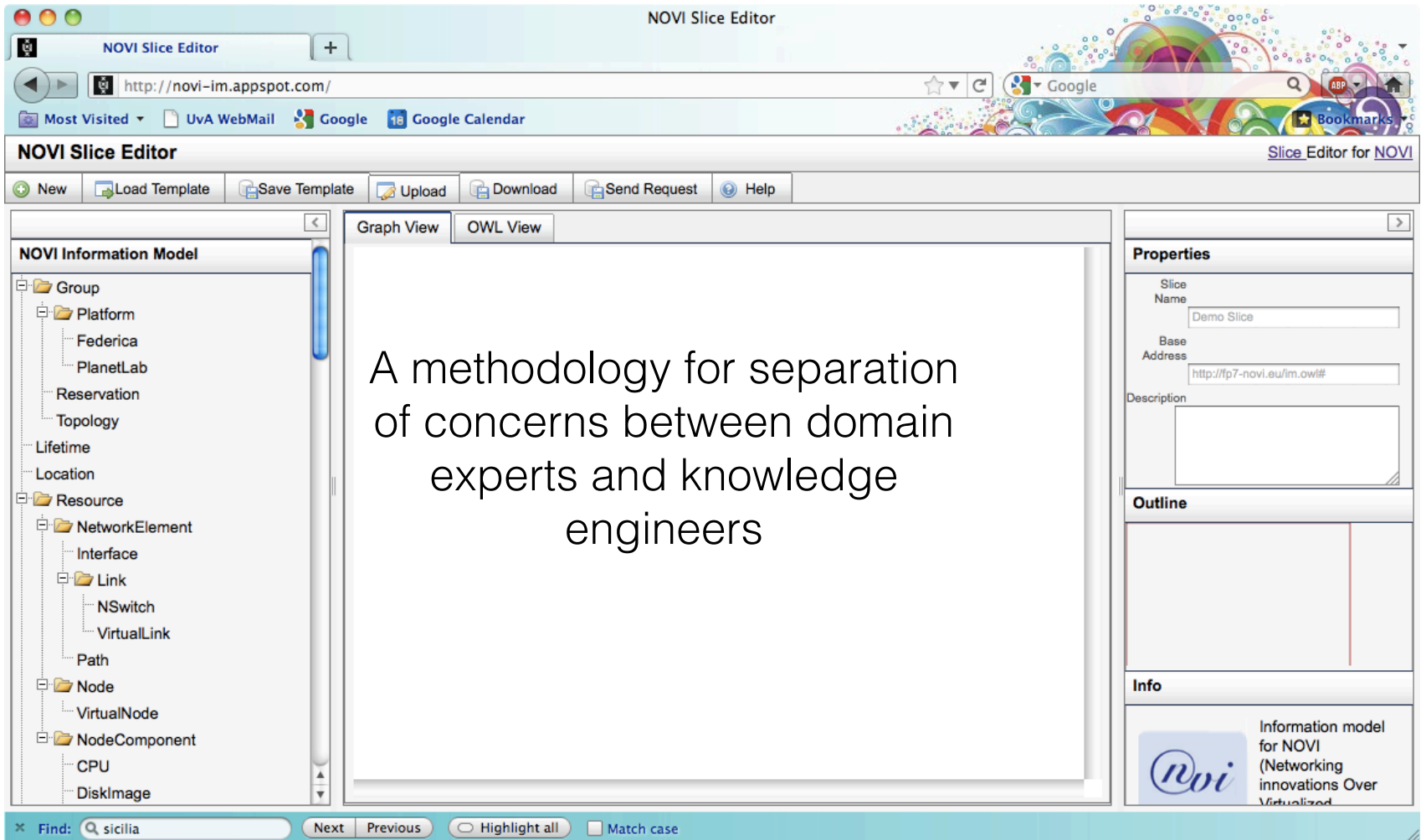


- The virtualization model:



The OIntEd editor

<http://indl-gui.appspot.com/>



NOVI Slice Editor

NOVI Slice Editor

NOVI Information Model

- Group
 - Platform
 - Federica
 - PlanetLab
 - Reservation
 - Topology
 - Lifetime
 - Location
 - Resource
 - NetworkElement
 - Interface
 - Link
 - NSwitch
 - VirtualLink
 - Path
 - Node
 - VirtualNode
 - NodeComponent
 - CPU
 - DiskImage

Graph View

OWL View

A methodology for separation of concerns between domain experts and knowledge engineers

Properties

Slice Name: Demo Slice

Base Address: http://fp7-novi.eu/im/owl#

Description:

Outline

Info

Information model for NOVI (Networking Over Virtualized)

Find: sicilia

Next Previous Highlight all Match case

W. Adianto, R.Koning, P. Grosso, A. Belloum, M. Bubak and C.de Laet,
OIntEd: online ontology instance editor enabling a new approach to ontology development
 In: Journal of "Software: Practice and Experience" 2012

NML and NSI

NML - Network Markup Language and NSI – Network Service Interface

within the OGF.

- See: “[Network Markup Language Base Schema version 1](#)”

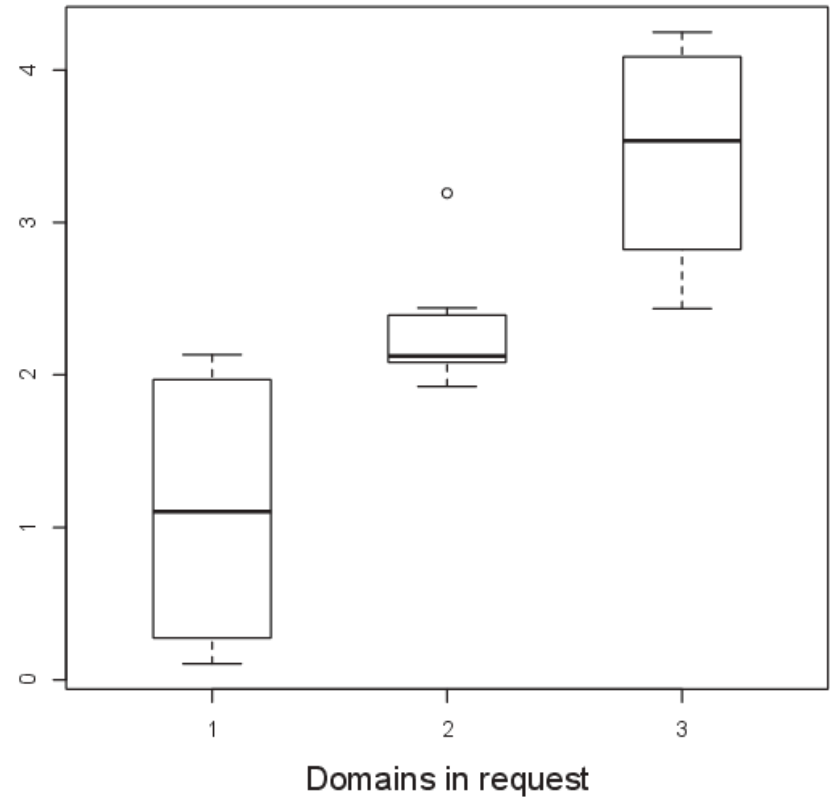
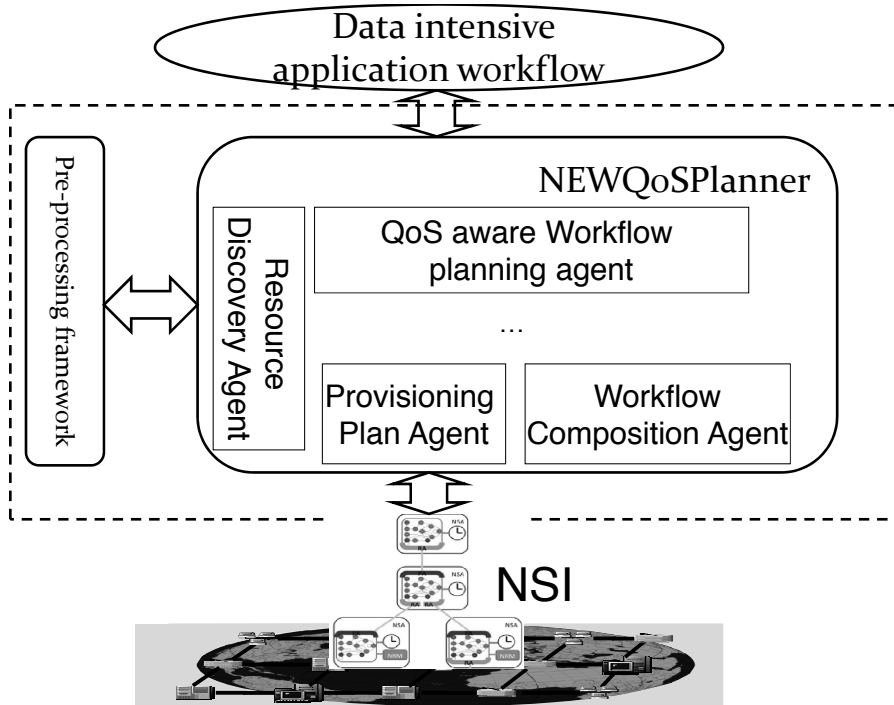
The Network Markup Language purpose is to create a functional description of multi-layer and multi-domain networks.

It can be used for aggregated or abstracted topologies.

Under development: the Network Service Interface Topology Extensions (Draft OGF Standard)

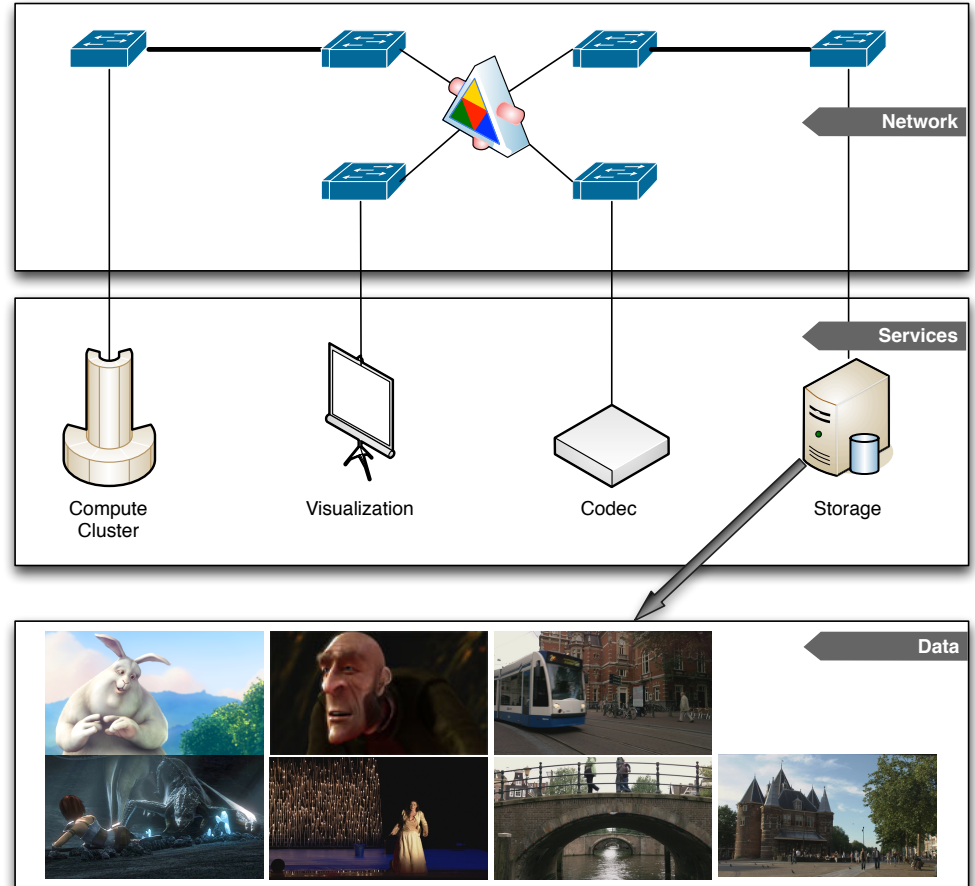
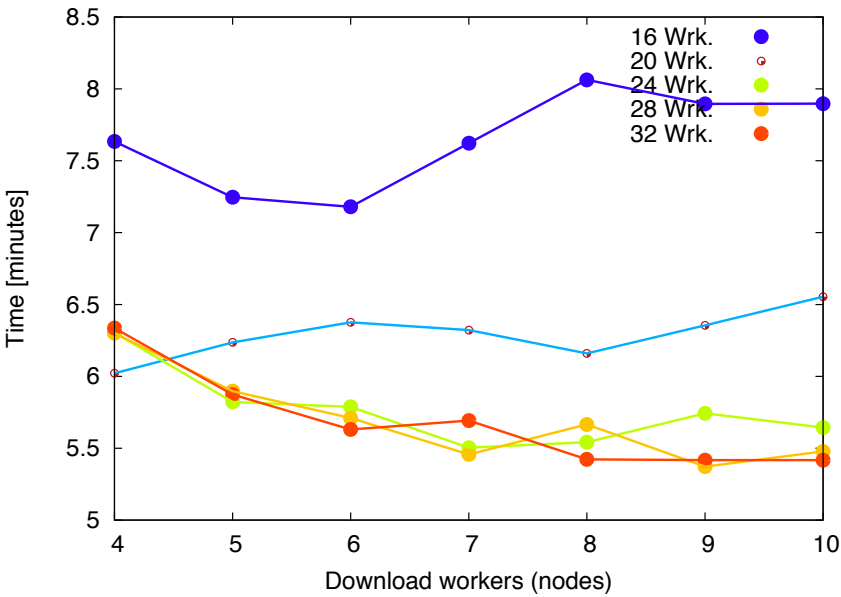
NewQoSPlanner

The NSI – Network Service Interface – creates on the fly connections between domains.

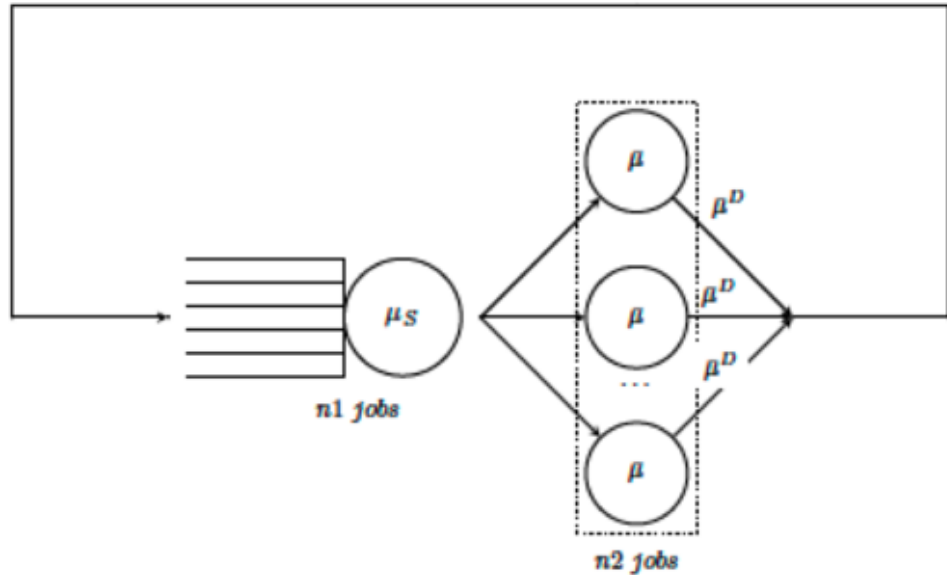
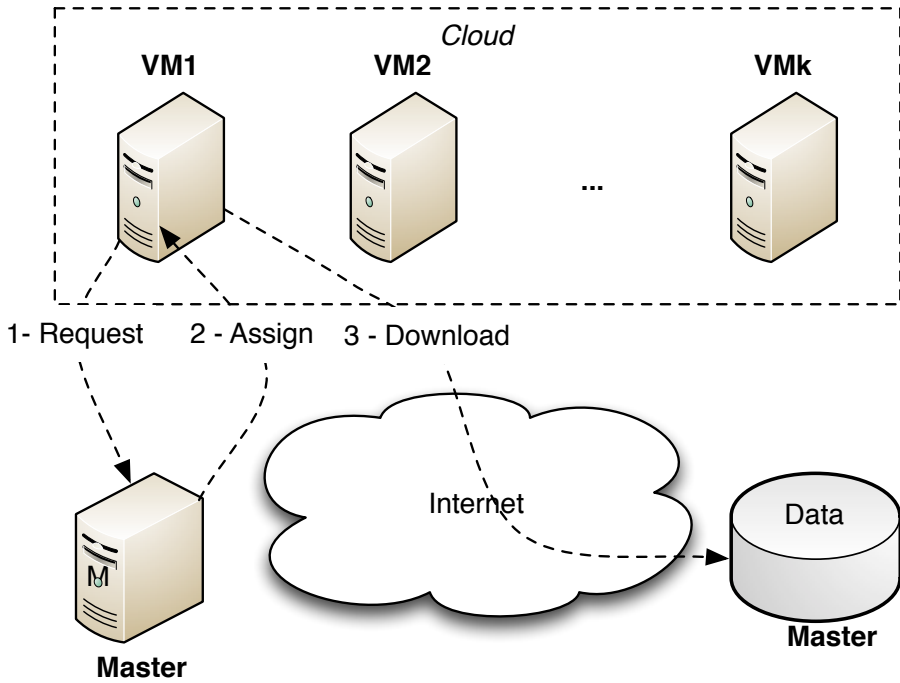


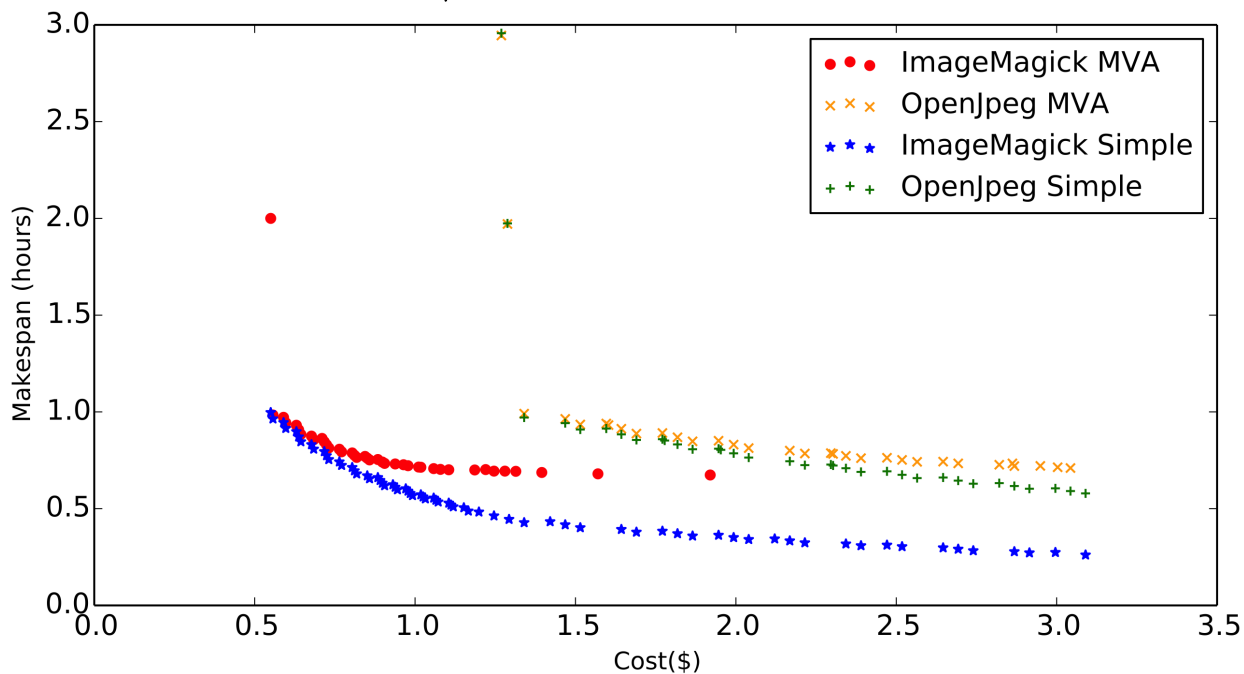
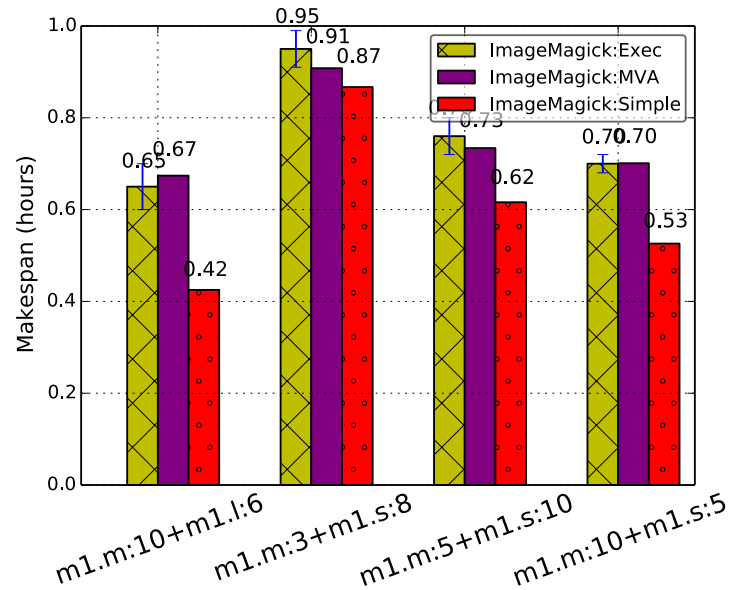
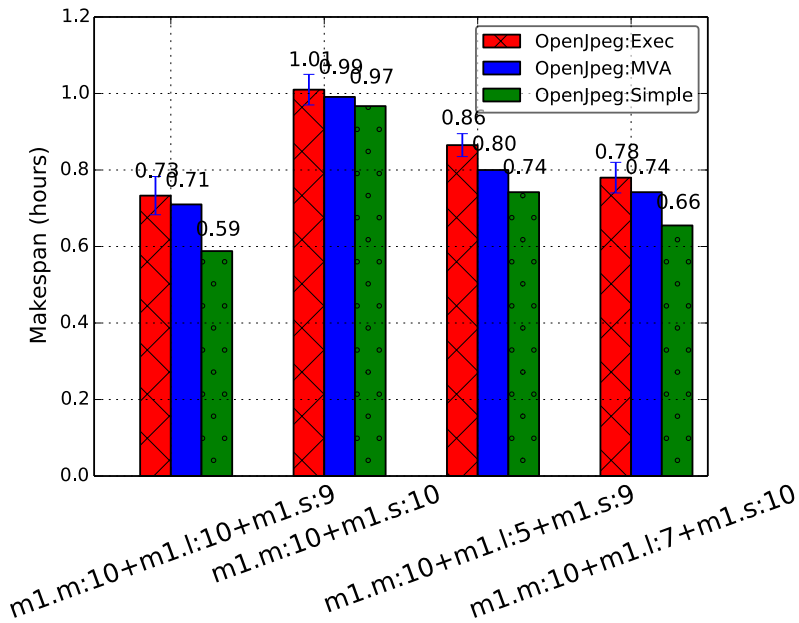
HyperFlow

Encoding times improve as the end nodes are connected via dynamic lightpaths



A queuing model approach





Cosmin Dumitru, Ana-Maria Oprescu, Miroslav Zivkovic, Rob van der Mei, Paola Grosso, Cees de Laat, "A Queueing Theory Approach to Pareto Optimal Bags-of-Tasks Scheduling on Clouds", accepted for Euro-Par 2014



Mission

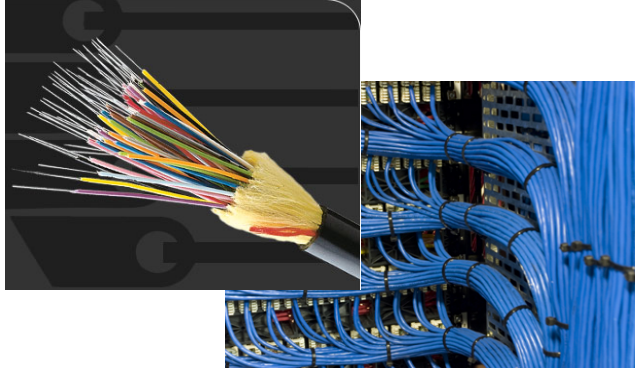
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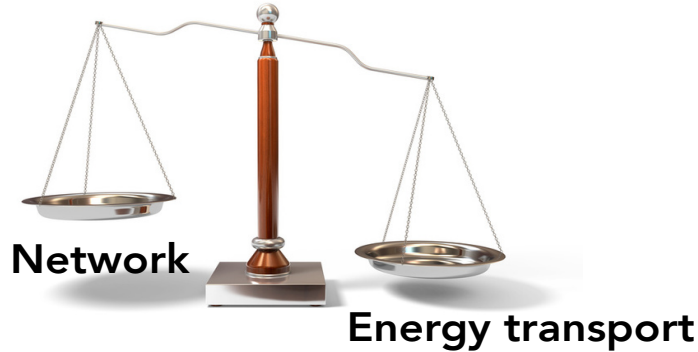


Green scheduling

Network infrastructures



CO₂ footprint;
Energy needed and lost

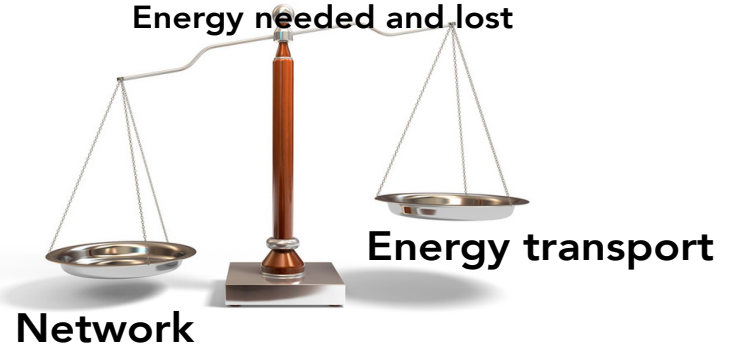


Bits to energy

Green energy sources

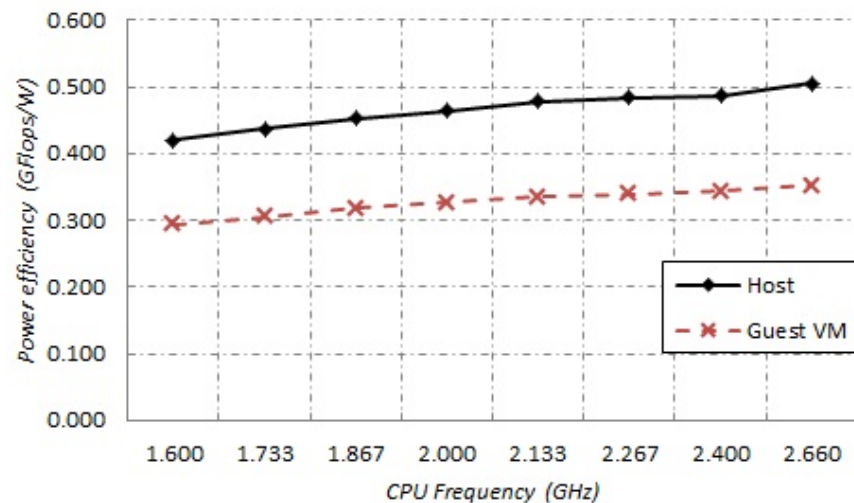
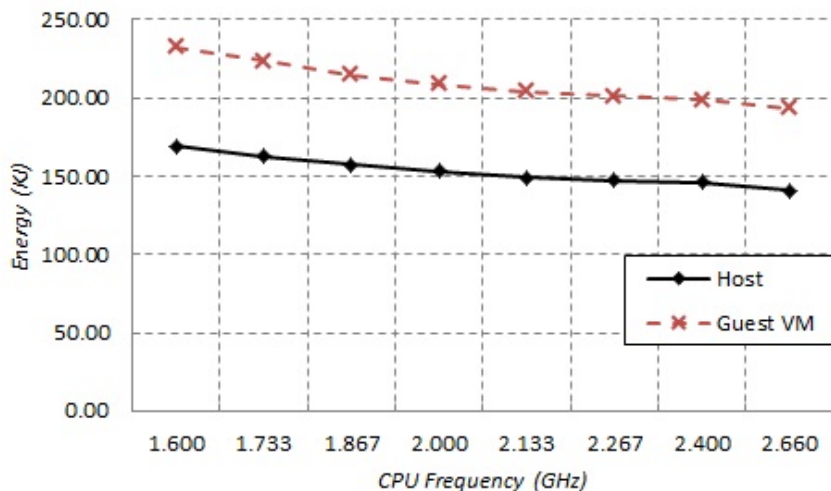
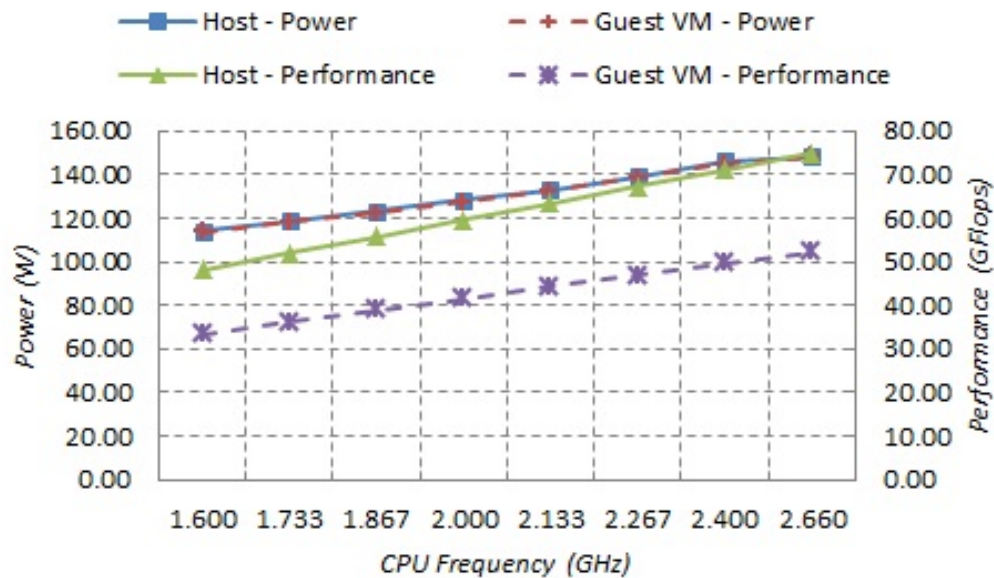


CO₂ footprint;
Energy needed and lost



Energy to bits

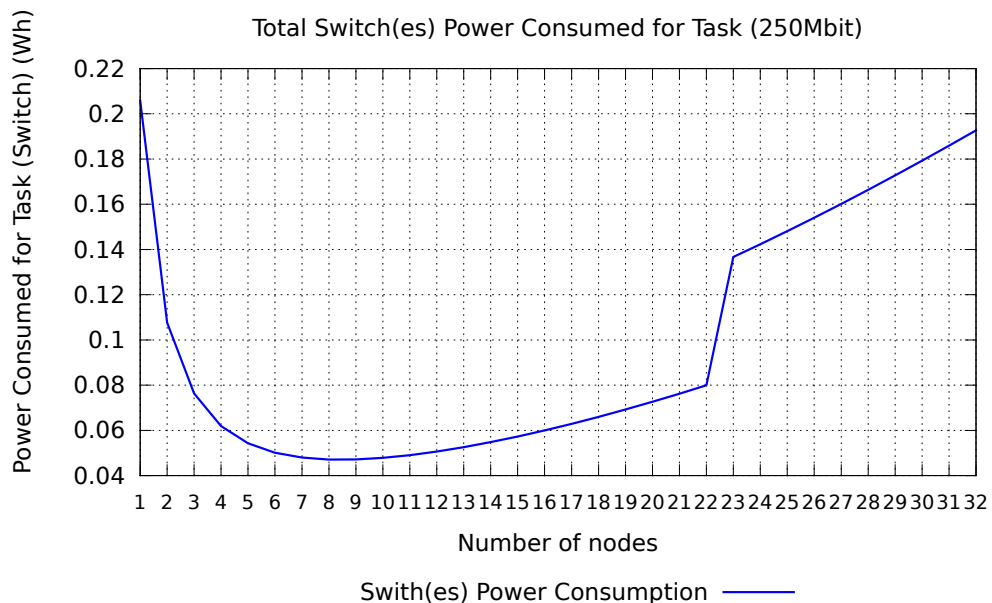
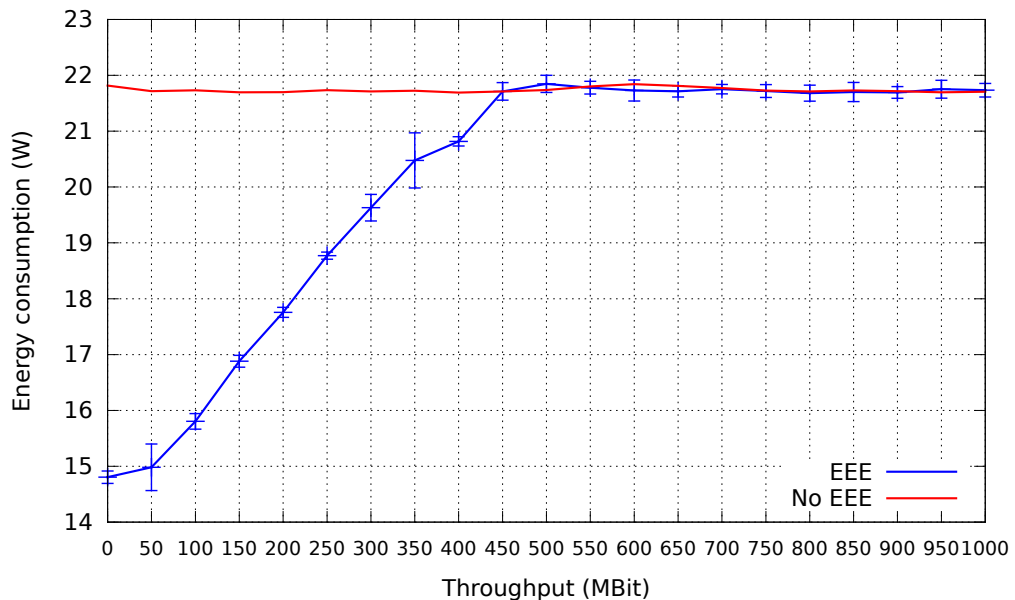
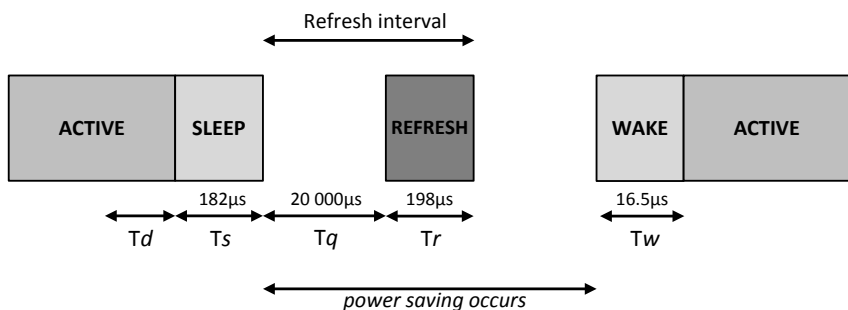
Energy saving in clouds



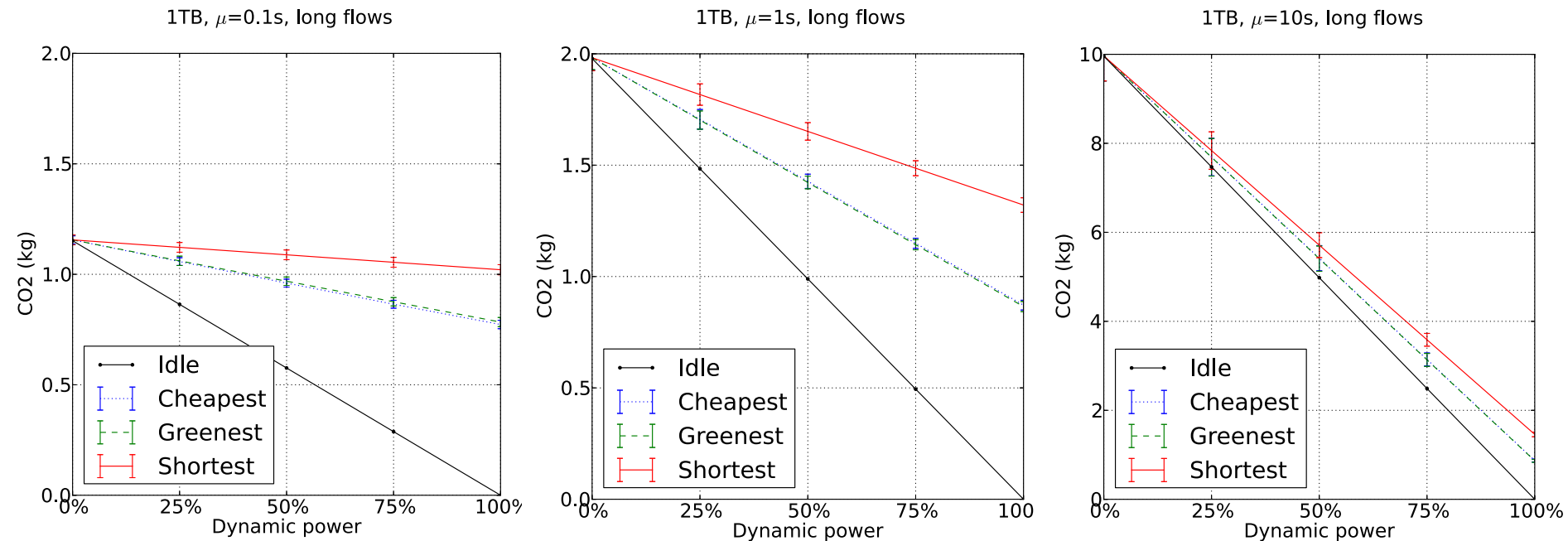
Quantifying the energy performance of VMs is the first step toward energy-aware job scheduling.

Energy Efficient Ethernet (802.3az)

Power savings techniques in hardware can be leveraged in architecturing communication patterns in data centra

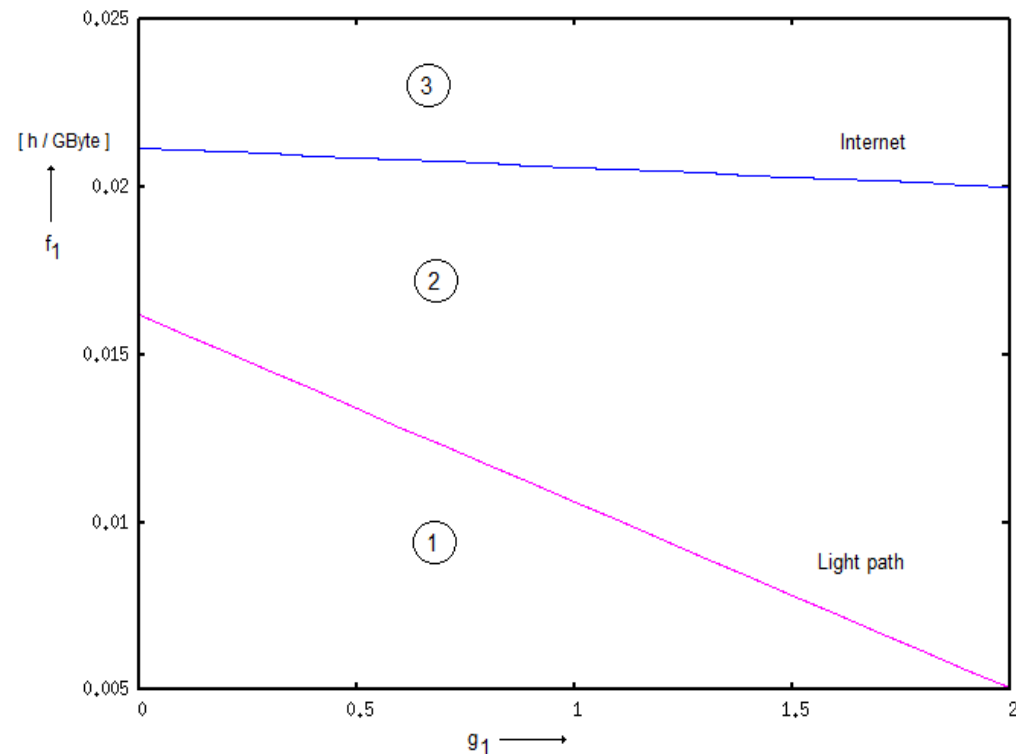


- Take a network (Esnet, working on using SURFnet data)
- Define the traffic model running on it
- Use the energy monitoring information and energy costs data
- Compare path selection strategies : shortest, cheapest and greenest



"A motivation for carbon aware path provisioning for NRENs" (submitted to eEnergy2014)

Results



In region 1 the task should be performed locally, independently of the type of transport network.

In region 2 the task can be performed remotely provided that the connection is a light path.

In region 3 the task should be done remotely for both types of transport networks.

Given different network paths we can identify decision boundaries as function of the task complexity.

ECO-Scheduling



The constant factor in our field is Change!

The 50 years it took Physicists to find one particle, the Higgs,
we came from:

Assembler, Fortran, COBOL, VM, RSX11, Unix, c, Pascal,
SmallTalk, DECnet, VMS, TCP/IP, c++, Internet, WWW,
ATM, Semantic Web, Photonic networks, Google, Grid,
Phyton, FaceBook, Twitter, Cloud, SDN, Data³, App's

to:

DDOS attacks destroying Banks and BitCoins!

Conclusion:

Need for Safe, Smart, Resilient Sustainable Infrastructure.

Questions?

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